Commercial Aspects of Shipping – Bunkers V

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Last article of the series on Bunkers deals with the issue of catalytic fines (Catfines). One may ask the reason for focusing only on this aspect of fuel quality as compared to the hot topic of sulphur and associated environmental issues. I think a lot is being written and circulated on the Marpol VI and its technical, commercial and legal implications. Catfines is a matter which though critical, misses the attention unless someone faces the difficulties and then it remains an individual company's problem.

Basics:

Refining: Once oil has been produced from an oil field, it is treated with chemicals and heat to remove water and solids, and the natural gas is separated. The oil is then stored in a tank, or battery of tanks, and later transported to a refinery by truck, railroad tank car, barge, or pipeline. Large oil fields all have direct outlets to major, common-carrier pipelines.

Separation: Modern separation involves piping oil through hot furnaces. The resulting liquids and vapours are discharged into distillation towers. In side the towers, the liquids and vapours separate into components or fractions according to weight and boiling point. The lightest fractions, including gasoline and liquid petroleum gas (LPG), vapourise and rise to the top of the tower, where they condense back into liquid. Medium weight liquids, including kerosene and diesel oil distillates, stay in the middle. Heavier liquids, called gas oils, separate lower down, while the heaviest fractions with the highest boiling points settle at the bottom. These tar-like fractions called ***residuum****, is literally the "bottom of the barrel".*

Cracking: A chemical process by which a chemical compound, usually organic, is broken down or cracked into simpler compounds. Cracking is accomplished either by the application of heat and high pressure, by the process known as thermal cracking, or by catalytic cracking, which is a combination of heat and a catalytic agent.

The reactions involved in cracking, especially in ***catalytic cracking****, are very complex; large molecules decompose into fragments, which may spontaneously undergo further change or may combine with other fragments. Under normal conditions the principal products from cracking hydrocarbon oils are hydrocarbons of lower molecular weight, mostly unsaturated. Some elementary hydrogen and carbon are always formed in the process. Normally the hydrocarbons are gaseous at the cracking temperature, but if heavy hydrocarbons are heated under pressure, cracking takes place in the liquid or condensed phase.*

Cracking has become greatly important in the petroleum-refinery industry as a means of increasing the production of gasoline at the expense of the heavier, less valuable products such as kerosene and fuel oil. The best-known catalytic processes, which have largely replaced the former thermal processes, are the fixed-bed and the fluid-catalytic processes that use alumina-silica gel powders as catalysts. In the fixed-bed process, the oil is passed through a stationary bed of solid particles; in the fluid-catalytic process, the particles are mobile and suspended in a current of oil vapors at 450° to 540° C (about 850° to 1000° F) at a pressure of 2.4 atm. [1]

Catalyst Fines

As seen above, the aim of catalytic cracker in refinery processing is to increase the quantity of lighter constituents or gasoline from the crude processed. In order to increase the surface area, the catalyst is broken into small particles which are in constant motion at high velocities colliding with each other and the containments. This results in further reduction in the size of these particles and thus the production of catalyst fines. While the intention is to retain the catalyst particles or fines in the catalytic cracker due to the high cost of the replacement of the material, this is not entirely possible to do so. A part of the catfines mixes with the oil streams that may be then used for blending of the fuel due to their high aromaticity and less likelihood of incompatibility.

The catfines are hard abrasive particles that if not reduced by suitable means, either ashore or onboard the vessels by an efficient fuel treatment can cause increased and at times severe wear in the engine. Fuel pumps, delivery valves, fuel injectors, piston rings and liners are the usual victims. In extreme cases, where the catfines find their way into the stuffing boxes, piston rods, especially those not surface-hardened, may also be severely affected.

It is not only the parts per million aspect of the catfines that is important, the nominal size of the particles is also

a crucial factor to keep in mind. The size of the particles can vary from very small (less than a micron) to 25+ microns. While the usual shape of the catfines is expected to be spherical, this is not a rule. The elongated catfines having a small cross sectional area in one direction can pass through the finest of the filters and cause damage to the engine due to their size in the second axis.

ISO Limit:

Guidance for Measures to Cope with Degraded Marine Heavy Fuels by ClassNK notes that "common to all engine models," desirable fuel properties at the engine inlet "that have departed far" from ISO 8217 include

- a total for alumina and silica one-fifth to one-tenth that permitted by ISO and
- a vanadium content one quarter or less the ISO-permitted level.

The limit specified in the ISO 8217 is the sum of the aluminum and silicon in elemental form. Eighty parts per million (80 ppm) limit was retained during the recent revision to the standards. Convinced that this is a matter of concern the author approached the Convenor of TC 28/SC 4/WG 6 Marine Specification with his views, excerpts as reproduced hereunder:

"……. Catfines is one of the major issues for the practitioners in the Maritime Industry. ……. the limit of 80 ppm for Al+Si is quite high and it would have helped if this limit could be reduced to a level that can be practically handled by onboard installations of purifiers/clarifiers and the filteration systems.

FOBAS has a good database in this regard which shows that the efficiency required of the centrifuges is very high when Al+Si increases beyond 50 ppm.

In view of the deteriorating quality of fuel oil, it has become necessary to take proactive measures to protect engines and the ancillary systems. While the bunkers may still be complying with the ISO 8217 (1996) RMG 35, the value of the elements such as Al+Si, Ash and the parameters such as MCR and CCAI …… important when they increase.

For example, the ISO limit for Al+Si (cat-fines ……) is 80 ppm, a value beyond 50 ppm becomes difficult to handle by the shipboard purification systems. While good operational practices can reduce the possibility of damage, a control at the start point itself goes a long way. The efficiency level required from the purifiers increases exponentially when the Al+Si ppm increases (while remaining with the ISO limit of 80 ppm).

The shipyards provide minimum margins while specifying the centrifuges and the engine maker requires Al+Si less than 10 ppm at the engine inlet. Further as the time passes and the machinery gets older, the efficiency levels drop. This compounds the problems and the ability of the centrifuges to handle and reduce the Al+Si to engine maker's acceptance levels reduces gradually"

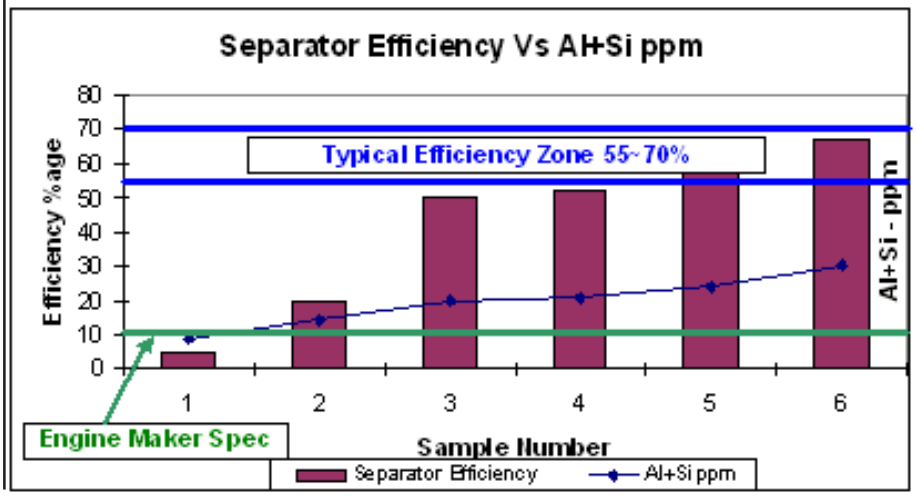
The response was very positive and a copy of the paper for future revisions was forwarded to the author. However, a review of the 13th SIBCON 2004 (23 – 25th September 2004) paper titled "Bunkering trends and Challenges for the next two years" revealed following:

"The next edition of the standard should be able to move forward regarding the issue of changing the catalyst fines limit. The industry has had a long experience of the current limit by now and, more importantly, there is significant improvement in the effectiveness of the shipboard treatment, particularly in the centrifuges for cleaning the fuel"

This paragraph in the paper raised further concerns as the situation could become worse. The Convenor's attention was brought to the possible implication of the paragraph, if put into action during any future revision.

"……. hope the intention is not to push the limit of 80 ppm higher because of the perception that "there is significant improvement in the effectiveness of the shipboard treatment, particularly in the centrifuges for cleaning the fuel". If this is the intention, ….. must say the result would be negative and extremely hard to cope with by the Shipping Industry. The damage caused by catfines is not only expensive to repair (mainly through expensive replacements) but also has the potential to jeopardize the safety of the ship staff, cargo and the ship itself.

1…. request you to advise your thoughts behind these wordings as written by you in your paper. My serious worry is that if the oil companies are able to even maintain this high limit of 80 ppm during the next revision (let alone increasing), in my view the impact on the shipping industry would be negative"



The response was extremely positive and hopefully, the matter of Catfines will be suitably addressed during the next revision, as can be seen from the reply received:

" ……The way I have written it indeed may imply that we can go to a higher level. I can see it now myself. I would like to assure you that the statement in that clause is to be interpreted to the contrary. …….. Thank you"

While we all face the "information overload" syndrome after the invent of internet and e-mails, author believes that it is essential for the industry practitioners to provide feedback to the authorities responsible for such matters, who generally take the feedback positively as coming from those who are directly affected by their decisions.

Getting rid of Catfines:

Some aspects of the problem

If the removal of Catfines was an easy matter, there would not be a need to write this article or even pursue for reducing the ISO limit. Please find some excerpts from various sources given below which further highlight this problem:

- ……. if the back wash oil from the secondary filter is returned to the settling tank, the cat fines cannot be removed from the fuel supply line. [2]

- ……. a number of potential problems with shore side fuel analysis which can lead to failure to detect cat fines. [2] Thus leading to inadvertent flow of catfines in the entire system if proper attention is not paid.

- When high levels of catalyst fines are combined with significant levels of waste automotive lub. oil, the fuel treatment system may not be relied on to reduce the levels of catalyst fines to tolerable levels for the engine. Thus caution should be exercised in using fuels with high levels of aluminum + silicon and significant levels of waste lub. oil.

Precautions to be taken:

Following are the precautions that may be taken to reduce the risk of damage by catfines:

- Under voyage charters or the COAs, at the time of stemming bunkers, one must be aware of the analysis statistics of port of supply being contemplated and if there are relevant any warnings issued by the laboratories.

- If it is the time charterer who is supplying the oil, the ship owner's technical staff or the ship manager entrusted with managing the ships should be well informed of above and liaise with the commercial and/or operations colleagues.

- A company wide Bunker Procurement, Handling & Management plan should be provided to the vessel that should take into account, amongst other, the following:

- In the charterparties and bunkering contracts, to try to keep the agreed value of ppm of Al+Si less than 50 (irrespective of ISO limit of 80 ppm) to ensure that the centrifuges can effectively bring this value down to less than 10 ppm at the entry to the engine.

- As far as possible bunker into empty tanks, proper sampling procedures, sample handling & management and documentation.

- Employment of analysis laboratories, expedient sample dispatch and try to provide analysis results to the vessel as soon as possible and in any case prior to using the bunkered oil. In case of doubt, also ascertain the size of the catfines in addition to the ppm.

- Have a system of informing Owners and charterers (including putting them on notice to protect owners' interest).

- Gravity settling, draining and handling of the drained oil.

- Heavy weather precautions to minimize the impact of mixing of the settled catfines. The precautions to include more frequent and amount of drainage, cleaning of filters and reducing the feed through the centrifuges.

- Avoid a long term build up of catalyst fines on the bottom of fuel oil storage and settling tanks. Cleaning of the tanks during dry dock could be considered. An effective solution, though expensive.

- A system of analyzing oil at the entrance of the engine through a system of fuel system audit to ascertain and improve the efficiency of the purification and filtering system.

- Provision of secondary filter after the centrifuges and tertiary fine filter at the entrance of the engine.

- After an encounter with high catfines, piston rings embedded with cat fines must be replaced and the liners re-honed to remove the catfines and any hardening caused due to excessive wear.

- During the overhauls, look for lateral scoring marks on the fuel pump plungers. These lateral marks are typical of high Catfines levels in the fuel.

- Pay special attention to the capacity of the centrifuges at the time of drawing up and/or approving the new building technical specification.

This list is not complete and there may be many more ways to minimize the potential damage by catfines. When a damage does occur due to catfines, it is extensive and the cost of repair/ replacement could run into hundreds of thousands of dollars in addition to the heavy loss of hire in a lucrative market.

References:

[1] Adopted from material provided by Mr. Deepak Kamran, an authority on fuel additives.

[2] Guidance for Measures to Cope with Degraded Marine Heavy Fuels by ClassNK

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